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ETHNOECOLOGY OF WHITE GRUBS (COLEOPTERA: MELOLONTHIDAE) AMONG THE TZELTAL MAYA OF CHIAPAS

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ABSTRACT.– A participatory study of white grubs of the family Melolonthidae among the Tzeltal Maya recorded traditional knowledge of this pest, and also maize cultivation practices utilized for deliberately or not managing the populations. This group of farmers has an ample knowledge of the bioecology of Melolonthidae present in their community. They know major life stages, and also natural enemies of larvae and adults, as well as the host plants used by the latter. Recorded agricultural practices that can reduce the damage caused by grubs include preparation of the fields; sowing; and hilling up soil around the plant. We contrast the knowledge of this Tzeltal group with knowledge generated by bioscientific methods, to make it possible to integrate and render the Tzeltal methods useful in possible programs for sustainable pest management.

Key words: White grubs, Melolonthidae, corn, Tzeltal Maya, Chiapas, traditional knowledge

RESUMEN.– A través de una metodología participativa se registró el conocimiento tradicional que un grupo maya-tzeltal posee acerca de la gallina ciega (Coleoptera: Melolonthidae) y las prácticas agrícolas del cultivo del maíz que realiza para el manejo de las poblaciones de la plaga. Este grupo de productores tiene un amplio conocimiento de la bioecología de los Melolonthidae que se presentan en su comunidad; conocen su estacionalidad y la de los enemigos naturales de larvas y adultos, así como las plantas hospederas de estos últimos. Las prácticas agrícolas registradas que tienen un efecto en el daño causado por gallina ciega son: preparación de los terrenos, la siembra y el aporque. Adicionalmente se contrasta el conocimiento de este grupo maya-tzeltal con conocimientos generados por el método científico, a manera de integrarlos y hacerlos útiles en posibles programas de manejo sustentable de plagas.

RÉSUMÉ.– Une étude participatoire sur le vers blanc de la famille Mélolonthidae parmi les Tzeltal Maya démontré une connaissance traditionnelle de ce parasite et des pratiques en matière de culture de maïs utilisées pour contrôler ces populations. Ce groupe de fermiers a une ample connaissance de la bio-écologie des Melolonthidae dans leur communauté. Ils connaissent les étapes principales de la vie de l'insecte, les ennemis naturels des larves et des adultes, ainsi que les plantes parasitées par les adultes. Les pratiques agricoles décrites ci-dessous qui peuvent réduire les dommages provoqués par le vers comprennent la préparation des champs; le nettoyage des mauvaises herbes; l'encemencement; et la formation de monts de terre autour de la plante. Nous contrastons le savoir de ce groupe Tzeltal avec les connaissances produites par des méthodes scientifiques, pour permettre l'intégration et l'utilisation des méthodes Tzeltal dans de futurs programmes de lutte antiparasitaire.

INTRODUCTION

The highlands of Chiapas have hosted, for more than 500 years, a rural population of Tzotzil and Tzeltal Maya (de Vos 1980). Their deep-rooted history has given them wide experience and knowledge of local resources. Part of this traditional knowledge has been recorded in the ethnobotanical work of Berlin et al. (1974, 1990), and the ethnozoological work of Hunn (1977), on Tzeltal folk classification.

However, there is more to be said about perception of Melolonthiids among the Tzeltal. Farmers of the Chiapas highlands refer to these insects as ***k'olom*** (Tzeltal Maya), ***k'onom*** (Tzotzil Maya) or *gallina ciega* (Spanish; lit. "blind chicken"). These organisms are the principal cause of losses to grain, vegetable, fruit and flower culture in the area (Ramírez et al. 1999). There is evidence (Ramírez and Castro 1997) that the level of damage caused by Melolonthiids in this region is similar to that recorded elsewhere in Central America (Quezada 1980; Ríos-Rosillo y Romero-Parra 1982; Rodríguez del Bosque 1988; Morón 1993). However, we do not know precisely which species are pests in the area, nor do we know enough about their biology to propose a pest management plan with optimal possibilities for success (Morón 1986, 1993). Most of the literature on Mexico's agricultural pests says that the name covers some eight species, but actually there are over 560 soil-dwelling larvae—root-eating, saprophagic or facultatively either—in the "*gallina ciega*" complex (Deloya 1993; Morón 1983; Morón et al. 1996).

Until now, no one seems to have studied ethnozoological aspects of scarab beetles in Mexico (Morón et al. 1997), still less the *gallina ciega*. We have only a few notes on consuming them as food (e.g. Ramos and Pino 1989: 21). As noted above, we consider it important to conduct ethnoecological studies on rural and indigenous knowledge of the Melolonthidae. Empirical knowledge might be very useful in developing strategies of management for these pests, and for conservation of other species in the same family.

Ethnoecology, like many other disciplines, has a role in community development. This discipline records traditional wisdom in a systematic manner, and relates it to productive practice as well as to global economy and to the world of rural cultivation (Vásquez 1992). Bentley (1992) notes that technical collaboration with rural people should be based on what they know (or do not know), including what they might need to learn, teaching it in such form that it can be consistent with what they do know, and can learn in a manner that allows synthesizing the new information with the old. With this view, we carried out the present work, taking into account also the point that success in sustainable pest management is based on a broad technical knowledge and/or traditional knowledge of the agroecosystem. Our objective was to record and analyze knowledge of Melolonthidae, and of maize cultivation practices for managing white grub populations thereof, among the Tzeltal of Balún Canal, Chiapas, Mexico. Additionally, we evaluated the possibility that this knowledge could be integrated with strategies for sustainable management of these grubs.

The Study Area.– This investigation took place in the community of Balún Canal, in the *municipio* of Tenejapa, Chiapas (a *municipio* is roughly equivalent to a county or township). This locality lies 22 km east of San Cristóbal de Las Casas, at 16 46′ 49″ north and 92 32′ 12″ west. It is some 2240 m asl. It has a temperate, subhumid climate with summer rain (C[w_2][w]), with temperatures around 14-16 C. The vegetation of the zone includes cultivated areas (principally maize and beans), and fragmentary remnants of oak-pine and montane mesophyll forest (based on data from the Laboratorio de Información Geográfica y Estadística de El Colegio de la Frontera Sur, 1997).

The Tzeltal of Balún Canal.– The population of the community is composed of Tzeltal Maya. As of 1990, there were 500 persons distributed in 80 households; 47% were male, 53% female; 35% did not speak Spanish (INEGI 1990).

In the same year, 45% were listed as economically active. Most (92%) were involved in primary production, principally maize cultivation (INEGI 1990). The fields were slash-and-burn, used intensively for two years. They were prepared for sowing in late winter and early spring. Sowing was done before, or at the beginning of, the May rains. The maize was harvested in autumn or the first part of winter. Because of the scarcity of cultivable land, as well as low yields and problems with erosion and pests, the Tzeltal megibrated seasonally to work for pay in the coffee plantations or cattle ranches of Chiapas (Robledo 1994).

The Melolonthid pests.– The term *gallina ciega*– literally, "blind hen" or "blind chicken"– is the common Spanish term for larvae of beetles of the family Melolonthidae. It also includes some Scarabaeid larvae, and other subterranean pests. According to Morón et al. (1997), this name has no known origin, and no equivalent in other languages. They note it may have arisen during the first years of Spanish colonization. The only relationships between these larvae and the name "blind chicken" seem to be their lack of conspicuous eyes and the possibility of their being eaten by chickens.

The Melolonthids go through a full transformation: egg, larva, pupa and adult. This cycle can take one to seven years depending on their geographic position. Most tropical species have cycles that are annual or biennial depending on environmental conditions (Villalobos 1995).

Larvae of Melolonthids are often associated with grasses, legumes, rosaceous plants, and plants of the nightshade family (Morón 1984, 1986). In Mexico they have attacked roots of maize, beans, sorghum, wheat, potatoes, rice, sugarcane, strawberries, carrots, spinach, tomatoes and onions (Morón 1984; Rodríguez del Bosque 1988). Damage can be light (15% or less of roots), moderate (up to 40%), or severe (over 40%), depending on cultivation, environmental conditions, and state of development of the insect at a particular time (Villalobos 1995). The third larval stage causes the worst damage (Morón 1984).

METHODS

Because of criticisms of ethnoecological investigation, especially its methods (Vásquez 1992), we decided to modify and/or enrich the investigation with new techniques for recording knowledge. Particiaptory investigation can be very useful in that it proposes strategies focused on participation of a larger number of agents involved in the process of investigation.

The community of Balún Canal was chosen due to the favorable disposition of the people and to earlier data on knowledge of the grubs that the people had provided before the investigation. Most of the heads of families were involved in a society called "New Balún Canal," an informal organization (not officially registered). This made it easy to work with participatory methods.

Field work was done from January to September of 1997, through 35 visits to the community, each one lasting two days and involving a Tzeltal interpreter. We held participative workshops and used various data-gathering techniques, such as direct observation and group interviews. We interviewed key informants in the course of informal conversation, and also gave guided and open-ended but standardized interviews. We will proceed to describe various techniques used for recording data.

Participatory workshops.– We held four bimonthly meetings with members of the "New Balún Canal" society, which included 54 heads of families. At the first workshop, with 32 persons (some being absent for wage labor), we explained the research. The intention of the meeting was to motivate those present to participate actively in the investigation.

In a second workshop, with 40 persons, the theme was the cultivation of maize and the activities involved in it. Systems of maize phenology were laid out, as were names for each phenological stage, and activities during the agricultural cycle.

The third meeting (49 persons) served to make known the principal pests affecting maize cultivation. We used pictures of maize plants; participants wrote down or indicated the organisms and the affected part of the plant. Individuals voted for pests considered most damaging. Thus we developed an ordered list of the five principal pests.

In the fourth participatory workshop, 30 members of the New Balún Canal organization worked on knowledge of larvae and adults of the Melolonthidae specifically. They were presented with larvae and pupas preserved in alcohol, and adults mounted on pins, to elicit classification and nomenclature. They were shown larvae of Melolonthidae of different subfamilies (Dynastinae and Melolonthinae), Scarabaeids, and other soil-inhabiting insects (Coleoptera: Elateridae; Lepidoptera; Noctuidae; Diptera), to elicit grouping and differentiation. Also they were presented with adult scarab beetles collected in the area, and also with other scarabs (Cetoniinae and Scarabaeidae) that could be confused with them. Once these organisms were classified, we wrote up on a sheet of cardboard the ecological attributes belonging to these organisms: where and how they live, what they eat, what enemies they have. When the Tzeltal referred to natural enemies, they were shown pictures of the animals (Hunn 1977), to make a more precise identification of the species to which they refer.

Group interviews.– These interviews involved local people directly involved in maize cultivation. As part of these activities, we encouraged conversations and interchange of ideas and information about the grubs. During these interviews, we worked with an average of 15 participants, to facilitate application of participatory techniques such as going over field inspections with them, elaboration of diagrams, and group discussions.

Interviews with key informants.– With the purpose of getting different perspectives on the problem of the grubs, interviews with key informants were given individually to 13 persons of different ages. These persons were selected in the workshops, in accord with their participation and knowledge. With them, we went deeper into their knowledge of the biology, ecology and classification of the grubs. We also took up aspects of maize cultivation practices that intentionally or unintentionally managed populations of the insects. The value of this type of personal interview is that it avoids bias that can occur in group interviews. Biases can occur in these groups when expression of real opinions is inhibited.

Direct observation.– This technique consists of observing intensively and systematically the management of the grubs in maize cultivation. Information obtained in the field was contrasted with information obtained in the workshops and interviews. As part of this activity, visits lasting two to eight days per month were made. Most visits to field sites lasted four days. Data thus obtained was organized and presented in the form of an agricultural calendar of maize cultivation.

Collection of entomological specimens.– We collected 320 specimens of soil (288 in nine fields and 32 in woodland near the community). Larvae of the *gallina ciega* complex were collected *in situ*, in unit sample of soil specimens (monoliths of 15 cm diameter by 20 cm depth), during February and March. Adults were captured in March to June (their flying period), using a light trap. Additional adult beetle material was obtained during a check of trees and bushes known to be wild host species, during twilight and early night (19:00-22:00 hours). Collections were made together with farmers, so as to collect more precise ethnoecological data. Also, we collected specimens of plants used as perches or host plants. Natural enemies were also captured, as were other soil-inhabiting larvae encountered. All this material was sent to specialists for adequate taxonomic determination, and deposited in the collections ECO-TA-E, M. A. Morón and B. Gómez.

Contrast and analysis of knowledge.– Contrast and analysis of traditional and scientific knowledge was done in a qualitative method, using comparative tables.

RESULTS AND DISCUSSION

Taxonomy.– One hundred percent of the Tzeltal farmers referred to the grubs as ***k'olom***. We do not know whether this word has any other significance. The Tzeltal can distinguish Melolonthid larvae from other soil larvae such as Noctuid moths (***wajchan***) and Diptera (***me'toyiw***). However, they cannot differentiate Scarabaeid from Melolonthid larvae, possibly because of their morphological similarity. In Mexico in general, *gallina ciega* applies to Scarabaeids, which suggests the term is equivalent to ***k'olom.***

In contrast, the Tzeltal differentiate the adults: Scarabaeids are ***kutuntza,*** Melolonthids ***chimol*** or ***umo'*** (Table 1). This finding differs from Hunn's (1977:295-297); he found that the Tzeltal used the term ***kuhtum ca*** for certain Scarabaeids (Geotrupinae) and Melolonthids (Cetoniinae). Hunn suggests that ***cimol*** is the word for rhinoceros beetles (Melolonidae: Dynastinae; possibly the species *Xylorictes thestalus).* He notes that the word ***umoh*** is utilized for June beetles (we think the genus *Phyllophaga* is meant and other similar twilight-flying scarabs (possibly *Anomala).* He mentions that "***cimol, umoh*** or ***kuhtum ca***" are the same (see Hunn 1977:297). They use the terms as synonyms for any adults of the *gallina ciega* group. Our differences from Hunn may be due to the fact that we worked in one community, while he worked in various Tzeltal communities. It is true that in other Tzeltal communities one can encounter other names; in El Madronal (Amatenango del Valle) the name ***xkumuk*** is used (Ramírez and Castro 2000). Also, we find that the older name was ***umo'*** and today the term ***chimol*** is more often used, since approximately the 1950s. This change has come about because of migrants from other communities, Tzotzil as well as Tzeltal. The name ***chimol*** or ***umo'*** includes at least the following species in the community studied: *Phyllophaga obsoleta, Anomala sticticoptera,* and two possible new species: *Phyllophaga* sp. 1 group *Phytalus,* and *P.* sp. 2 group *Anodentata.* However, it is possible that other species of adult Melolonthids have no special name. These are: *Hoplia mexicana, Xylorictes thestalus, Cyclocephala alexi, Phyllophaga* sp. 3 group *Schizorhina,* and *Ancognatha sellata.* The larval phases of these are possibly included in the *gallina ciega* complex. The species that possess a name in Tzeltal during their adult phase are those which were sometimes consumed by local people, and/or species that come in great numbers around houses, attracted by lights. However, some species that inhabit forested land have no name (Gómez et al. 1999a).

In this context, it must be emphasized that ***k'olom*** is the term used in most of the Tzeltal region for the larvae stage. Scarabs possess different names in the various communities of the Tzeltal region: ***chimol, umo', xkumuk'***. Berlin (1973) notes that in folk classification, when a name goes beyond its geographic limits and extends to a wider region, it is because the term has gained a large cultural signifi-

TABLE 1.– Designation in Tzeltal of Balún Canal, Chiapas; Spanish; and English for scarabaeiform beetles and larvae.

Description	Tzeltal	Spanish	English
Larvae of Melolonthid and Scarabaeid beetles	***k'olom***	*gallina ciega*	beetle grub, white grub
Adults of Melolonthid species mentioned	***chimol, umo'***	*ronrones, escarabajos de Junio*	beetles, scarabs, June bugs
Adults of Scarabaeids (*Geotrupes* sp., *Copris* sp.)	***kutuntza***	*Escarabajos, estiercoleros, "rodacacas"*	beetles, scarabs, dungbeetles

cance. The wide use of the name ***k'olom*** can be attributed to the importance of the insect as a pest of maize.

Bioecology.– Development. Apparently, the Tzeltal community studied ignore fundamental aspects of the process of metamorphosis. However, 100% of the 13 persons interviewed know that ***chimol*** or ***umo'*** adults are the progenitors of the larvae (***k'olom***). They suppose that these proceed from eggs of the ***chimol*** or ***umo'***. Only two of the 13 know that the larva goes through a pupal stage. They have observed that from these "little balls in the ground" (as they call them) issue adult scarabs. The few people who know the pupal stage and relate the different stages to the adults are persons of advanced age. It is possible that the above follows from the relative short duration of the pupal stage—30-45 days in *Phyllophaga* according to Morón (1986). One could also argue that the pupal phase occurs when the soil is resting and the Tzeltal are not active in the fields, and because of this cannot detect the pupae.

Life cycle. – It is evident that the Tzeltal of Balún Canal have knowledge of part of the life cycle of these scarabs. However, they cannot recognize the distinct larval instars or (usually) associate the pupae with the life cycle. Also, during the third workshop, 100% of the participants agreed that the duration of the life cycle is one year. Those interviewed mentioned that each year there are larvae as well as adults, and that they occur in similar abundance each year. The group mentioned that the larvae are present in the maize fields during nine months of May to February, and reported that the greatest abundance of larvae occurs in August. The farmers also noted that the adults fly from March to June. They have observed that adults fly during a period of one to three hours, starting around 19:30 to 20:00 p.m. The foregoing fits with results of scientific research in highland Chiapasm Mexico (Ramírez and Castro 1997) and other countries of Central America (Lastres de Rueda 1996; Méndez et al. 1996; Mendoza 1996), and can be compared with field observations (Table 2).

Host trees and perch sites. – In the third workshops, we found that 100% of participants knew that the ***chimol*** or ***umo'*** eats leaves of the *ajil* or ***jnak*** (*Alnus acuminata*

TABLE 2.– Comparison of information obtained in this study with that reported in biological research in the area or in similar areas

THIS STUDY		OTHER INVESTIGATIONS
Time of larvae	May - Feb.	7 May - 10 Jan. (Ramírez and Castro 1997)
Time of major damage	August	July - August (Ramírez and Castro 1997; Lastres de Rueda 1996; Mendoza 1996; Méndez et al. 1996)
Density of larvae in roots during critical period	44 indiv/m^2	38 indiv/m^2 (Gómez et al. 1999b)
Time of flying of adults	March - June	April - May (Ramírez and Castro 1997); April - June (Gómez et al. 1999a)
Hour of flight	19:30 - 22:30	19:30 - 21:00 (Ramírez and Castro 1997); 19:00 - 23:00 (Gómez et al. 1999a)
Spatial distribution of the larvae during period of attacks	patches	patches (King and Saunders 1984)
Life cycle	1 year	Univoltine, 1 year (King 1996)

ssp. *arguta*, Betulaceae) and the ***chiquinib*** *(Quercus crispipilis*, Fagaceae). In accord with what is reported for other Melolonthidae, another host tree of *P. obsoleta* could be *Erythrina americana* (Fabaceae; Morón 1997). 70% of the Tzeltal mentioned plums, peaches and pears as possible hosts. However, we observe that these trees do not become defoliated and are used only as perch sites by the scarabs. Host plants identified in other work (Gómez et al. 1999a) that are not recorded as part of traditional Tzeltal knowledge are ***siban*** *(Cornus excelsa,* Cornaceae—used in the community for firewood); ***tujkulum chix*** *(Solanum myriacanthum,* Solanaceae), whose spines can wound people in the woods; and *Senecio sancristobalensis* (Compositae), which lacks a local name, possibly because it lacks use or importance for this ethnic group. These three species are probably not part of the Tzeltal's store of scarab knowledge because they grow in the woodlands and are visited by the scarabs at night (Gómez et al. 1999a), outside the view of the Tzeltal.

Habitat. – The Tzeltal know that the ***k'olom*** occurs in different habitats. They have observed that these larvae live in agricultural or forest soils, and that on various occasions it is possible to find them in rotting treetrunks. Similarly, they note that the larvae eat roots of maize, beans, potatoes, and various trees, as well as rotten trunks and decomposing leaves in the soil of the woodlands. The scientific literature, and observation during the present study, suggest that the habitats of the various species of *gallina ciega* are different. *Phyllophaga obsoleta* and *Anomala sticticoptera* are principally associated with agricultural soils (King 1996; King and Saunders 1984; Morón 1988; Morón et al. 1997; Ramírez and Castro 1997), while the rest of the species appear to be confined to forest soils (Morón *et al.* 1997; Ratcliffe and Delgado 1990).

Natural enemies. – The workshops and interviews indicated that various enemies are recognized (Table 3). The Tzeltal have observed that the larvae are consumed by animals such as the skunk (***pay***), armadillo (***majiltibal***), pig (***chitam***), domestic fowl (***me'mut***), and various wild birds (***tetikil mut***), especially the great-tailed grackle (***jojmut***). The Tzeltal of Balún Canal recognize as predators of adult Melolonthidae the domestic dog (***tz'i***), the cat (***xawin***) and the wildcat (*cis balan*). This suggests that the combined effect of domestic and wild animals animals could contribute to the regulation of grub populations.

With data collected in the fields, we could determine other less conspicuous natural enemies, unknown to the Tzeltal. These include a fungus, *Beauveria bassiana* (Deuteromycetes), and a wasp, *Pelecinus polyturathor* (Hymenoptera). The lack of Tzeltal knowledge of such small or microscopic natural enemies is explained by Bentley (1992). This author mentions that size can be a limiting factor in traditional knowledge. Moreover, Hunn (1977) suggests that the low density of solitary wasps like *P. polyturathor* can explain why they have no names in the community.

Use of Melolonthids for human food.– During the larval phase, Melolonthids are not eaten by the Tzeltal, and have no use in the area studied. In earlier times, there was a custom of eating scarabs toasted on a *comal* (flat griddle). This habit continued until about 30 years ago. Today, few eat these beetles;[1] the custom has gradually been lost. A possible explanation is that the Tzeltal, in constant contact now with industrial products, have changed their foodways. This phenomenon could be an indicator of change in the quality of life among the Tzeltal, due to the introduction of new types of foodstuffs, leading to a decrease in the value placed on natural foods obtained in the fields. We have observed that, in the community studied,

TABLE 3.– Principle Natural Enemies of the Melolonthids Observed by the Tzeltal of Balún Canal, Chiapas

Tzeltal name	Spanish name	English name	Scientific name	Phase eaten
Pay	*zorillo*	skunk	*Mephitis macroura* and ?*Conepatus mesoleucus*	larvae
Mayiltibal	*armadillo*	armadillo	*Dasypus novemcinctus*	larvae
Chitam	*cerdo*	pig	*Sus scrofa*	larvae
Me'mut	*gallina*	fowl, chicken	*Gallus gallus*	larvae
Jojmut	*zanate*	great-tailed grackle	*Cassidix mexicanus*	larvae
Tz'I	*perro*	dog	*Canis familiaris*	adults
Xawin	*gato*	cat	*Felis domesticus*	adults
Cis balam	*gato de monte*	margay	*Felis wiedii*	adults

consuming adult Melolonthids are looked down on—it indicates low status. We do not know what effect this change may have had on increases of the populations of *gallinas ciegas*. Ramos and Pino (1989) record the consumption of *Phyllophaga* by Nyahnyu (Otomi) and Nahua in some regions of Mexico, but as larvae or pupae. Hunn (1977) notes that the Tzeltal eat ***chimol***, but does not record which species. The results of our workshops and interviews suggest that the species were *Phyllophaga obsoleta, P. sp.(Phytalus)* and *P.sp.(Anodentata)* (Gómez et al. 1999a).

Agroecology.– In this section we present and discuss findings on certain agroecological aspects of the cultivation of maize (***ixim***) relevant to consideration of the grubs.

Agronomic importance of the *gallina ciega*.– Twenty-eight percent of 49 farmers interviewed in the second workshop stated that the grubs are the most important pest of maize. However, 30% considered that first place belonged to the gopher (***baj***, *Heterogeomys sp.*). Still others had other opinions: 17% voted for corn borers (***wajchan***, Lepidoptera), 17% for rats and mice (***ch'o***), and 8% for squirrels (***chuch***). These results suggest that the ***k'olom*** is the principal invertebrate pest of maize. However, there is no special form of control, except cleanup by hand or with a hoe.

According to those interviewed, symptoms of damage by grubs are yellowing and *acame* of the plants; *acame* is a local term for blowdown (falling over of plants due to root loss followed by wind). Damaged shoots can easily be pulled from the ground. Nearby soil is then examined; about three to five grubs can be found per plant. 100% of the Tzeltal mentioned that damage is present year after year, at the same level, in patches in the fields. The period of the most severe attacks is August (Figure 1). Symptoms of damage are similar to those recorded in field work elsewhere in Mexico and Central America (Table 2).

Calendar and agricultural practices.– The Tzeltal of Balún Canal have a calendar for their c activities (Table 4 and Figure 1). This calendar is flexible, exact dates being determined by environmental conditions prevalent in a given year. Berlin et al. (1974) observed a calendar similar to that reported in the present study. In this calendar, the agricultural cycle is strictly correlated with a "Tzeltal native calendar" (Figure 1).

The farmers of the community carry out agricultural practices that can have positive or negative effects, deliberate or unintended, on the grubs. Four—preparation of land, cleanup, sowing, and hilling up soil around stalk bases (the *calzado* or *aporque*)—can have a negative impact on grub damage.

Land preparation. – The farmers state that preparing the soil (see Table 4) lets them loosen the ground, eliminate weeds, and kill potentially damaging organisms. Thus this practice permits better drainage and exposes the larvae of Melolonthidae to attacks by their natural enemies, reducing their populations. The former was also observed by Musick and Petty (1974, cited in Carballo 1996), who mentioned the negative effect that soil preparation had on the grubs.

Sowing. – Sowing of maize (Table 4) follows the initial cultivation. One hundred percent of the farmers stated that the sowing consists of putting 4-5 seeds in each hole. Sowing follows a more or less definite pattern: holes are made a meter apart (in each direction). If this is done well, it is not thought of as a control measure, but it reduces the problem of grubs. The strategy can reduce damage by increasing the biomass of the maize root system. The plants can sustain more wind action, reducing *acame*. It is possible that the plants can compensate better for root-eating activity in comparison with isolated individual stalks. Indeed, some plants affected by

TABLE 4.– Agricultural activities; their stated purposes; their possible effects on management of grubs

Activity	Description	Objective	Effects on *gallina ciega*
Preparation of the land	If the field is being cultivated for the first time, or after a long period of abandonment, slash-and-burn cultivation is used. If the field has been used recently, it is cleared by hand or with hoes. Then the soil is moved, with manual elimination of pests.	This clears the land to create a biotic and abiotic environment favorable for cultivation.	Grubs are eliminated as found, being killed by foot or hoe, or leaving them exposed to birds and sun.
Sowing	4-5 seeds are placed in a hill. This establishes cultivation.	Sowing several seeds strengthens the support system of the plants.	They can then better withstand the root-consuming activity of grubs and other soil pests.
Cleanup	Weeding, manually or with hoe. Only one person (of 10 interviewed) used herbicides.	This reduces competition by weeds, and improves visibility in the field.	It possibly diminishes the densities of grubs
Hilling	This involves hilling soil and organic material around the base of the maize plant, using hands or hoe.	It provides a more solid support for the plants, preventing blowdown. It also maintains the humidity of the soil around the maize stalk.	It is a form of fertilization that can diminish the damage by grubs through incorporating more available nutrients in the root zone.
Doubling over	Plants are bent over, at ca. 1.3 m above ground.	This is done to avoid rotting of maize in the ear through humidity due to rains. It also reduces blowdown and bird damage.	It has no known effect on the grubs.
Harvest	Ears are collected and taken to a secure place. Removing grains from ears is done just before consumption or utilization of the grain.	This allows utilization of the product.	It has no evident effect on the grubs.

blowdown because of late grub damage can still render normal ears of corn and can be harvested.

Hilling up. – This is an activity (Table 4) carried out by the Tzeltal to give more firmness to the plants in the face of wind and rain. With this practice, consciously or unconsciously, the farmers avoid blowdown provoked by weakening of the root system by soil pests such as the grubs. This activity is done just before the damage becomes evident (May-June).

The Tzeltal indicate that blowdown can cause loss of the product, through damage by rats, squirrels and other animals or through decay. The function of hilling up in diminishing damage can be related to better growing of roots in the hill, which may also have more organic material. An alternative explanation has been proposed by Cruz (1999), who has observed that in one locality of the Chiapas highlands the hilling up increases the number of larvae in the roots. This greater density—which does not necessarily increase damage—is probably due to the larvae eating the organic matter added around the plant bases. Villalobos et al. (1997) have demonstrated experimentally that the content of organic material has a negative effect on root-eating activity by white of *Costelytra zelandica*. The foregoing

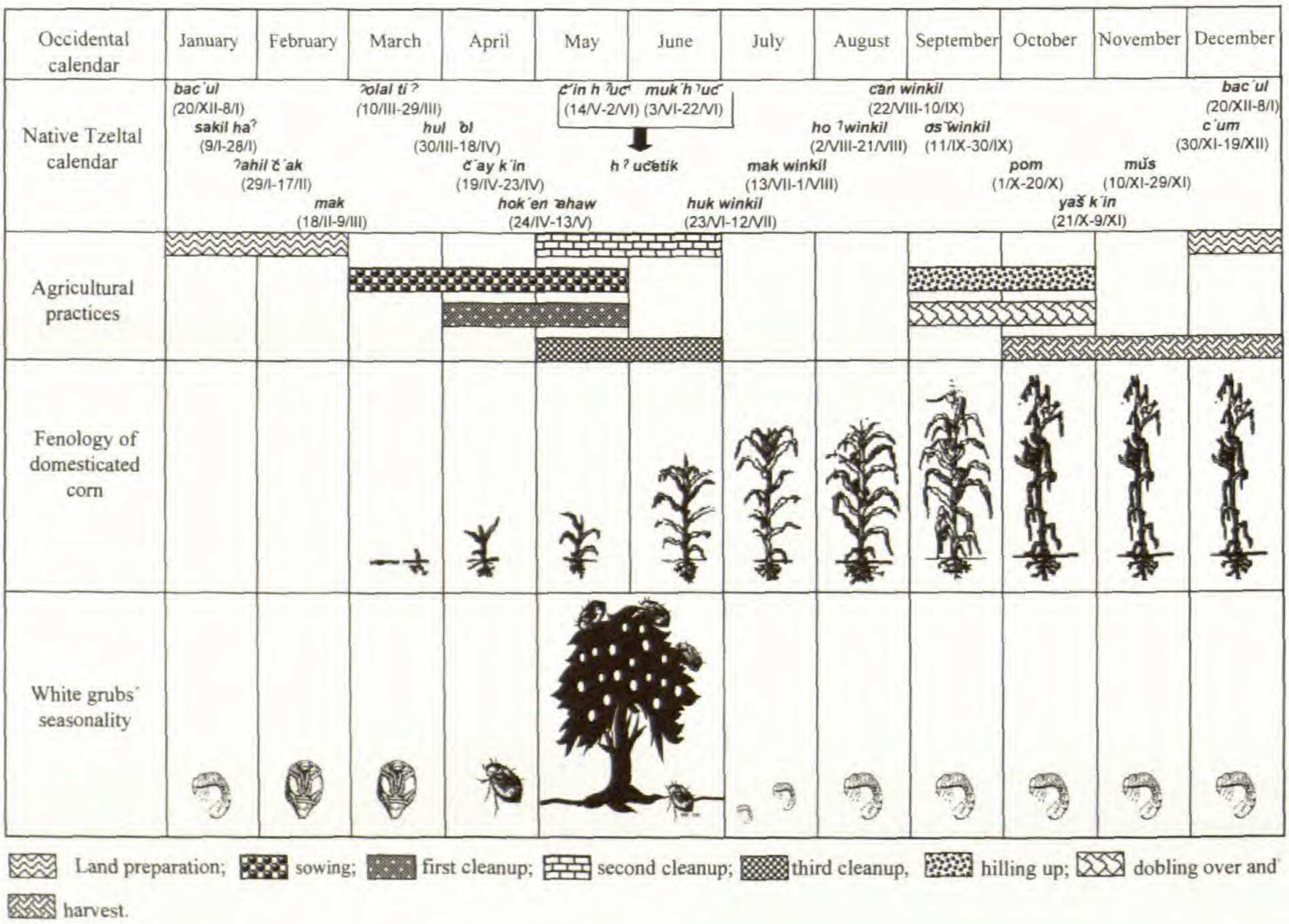

Figure 1. – Agricultural cycle (calendar, practices and fenalogy) of domesticated corn in Balún Canal, *municipio* of Tenejapa, Chiapas and its relationship to white grubs' seasonality.

suggests that hilling up benefits cultivation by adding nutrition to the plant as well as by reducing damage by grubs.

Cleanup. – The farmers carry out 2-3 cleanups of weeds in the fields, to reduce competition of weeds with maize (Table 4). They state that this can reduce infestations of grubs, in that they can kill grubs while weeding. Various authors have suggested that vegetation in the form of pastures (King 1985, 1996) and weeds (Carballo 1996 and references therein) permit the soil to host higher densities of grubs. We assume that this is due to higher survival rates of immature stages, greater chances of oviposition (associated with less compaction of soil), greater availability of food, favorable microclimate, and lower levels of parasitism and predation. However, we think that cleanup of the field also eliminates alternative foods, and centers the grubs' attention on the roots of the cultivated plants.

The Tzeltal and Sustainable Management of Grubs.– Sustainable management of agricultural problems caused by grubs has been defined as a strategy that presents characteristics qualitatively different from integrated pest management, and which is based in ecological, economic and social principles (Villalobos 1995). This author recommends saving traditional agricultural knowledge and practice as one of the principles to achieve this aim. Taking account of this, we advised studying and presenting to the community the effects that could follow from sowing and hilling up in managing the grubs. These activities had not been seen as related to the problem. The information produced by these studies could through light on conditions in which the effect could be better exploited.

The intervention of domestic animals during preparation of the land and cleanup of weeds could be developed to reduce the population of grubs. The renewal of consumption of adults by members of the community could also contribute to regulation of insect populations.

The information possessed by the Tzeltal of Balún Canal about hosts and hours of flying of the adults could be relevant in campaigns of massive collection, as proposed by Cruz et al. (1998). These campaigns could combine with initiatives to use adults of noxious species as food for domestic animals such as fowl and pigs.

The incorporation of organic matter in cultivation, directly via hilling up or through other means (incorporating agricultural wastes and animal dung), could be helpful. Such improvements could improve soil fertility and help reduce damage by grubs, and even help any possible beneficial activities of these insects (Villalobos 1994).

Information on ecology and life cycle of the beneficial and noxious species of Melolonthidae will be fundamental for proposing strategies for a sustainable management of white grubs that would be viable in the community. Ultimately, it will be necessary to evaluate the economic significance of the grub damage in maize cultivation in Balún Canal, to get a clearer diagnostic of the problem and confront it better.

CONCLUSIONS

The principal conclusions of this investigation are:

The ***k'olom*** is a Tzeltal term used for the larvae of a species complex of Melolonthid beetles, of which *Phyllophaga obsoleta* and *Anomal sticticoptera* possibly cause agricultural damage.

Among the Tzeltal, Melolonthids and Scarabaeids are differentiated as adults, but not as larvae.

The Tzeltal of Balún Canal use the terms ***chimol*** or ***umo'*** for the species *Phyllophaga obsoleta, P. sp.* 1 group *Phytalus, P. sp.* 2 group *Anodentata*, and *Anomala sticticoptera*.

The group knows the duration of the life cycle, the larval stage, the adults, and the hour of flight of the latter.

Few know the entire cycle; a large majority is ignorant of the pupal stage, and none are aware of the different larval instars.

The farmers recognize various natural enemies, all vertebrates. They do not know of entomopathogenic microorganisms or invertebrates that participate in natural regulation.

We record for the first time the consumption of adults of *Phyllophaga* by humans in Mexico.

The Tzeltal of Balún Canal have agricultural practices that reduce damage by the grubs. These practices include preparation of land, sowing, and hilling up soil around cornstalk bases.

We should consider as highly valuable the management knowledge, and also non-awareness, found among the farmers.

NOTES

[1] México leads the world in insect-eating, with more than 200 species consumed (Defoliart 1997), so it is not unusual that the group studied here consumes insects. Ramos and Pino (1989) mention that it is surprising that, though scarabs constitute a significant part of the order Insecta, their consumption worldwide is not well known. Some examples of Melolonthids consumed in other parts of the world include: Adults of the genus *Pyronota* are consumed by the Maori of New Zealand (Miller 1974); *Podischnus agenor* is eaten by the Yukpa of northeast Colombia and *Megaceras crassum* by the Tukanoan peoples of southeast Colombia (Defoliar 1997).

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